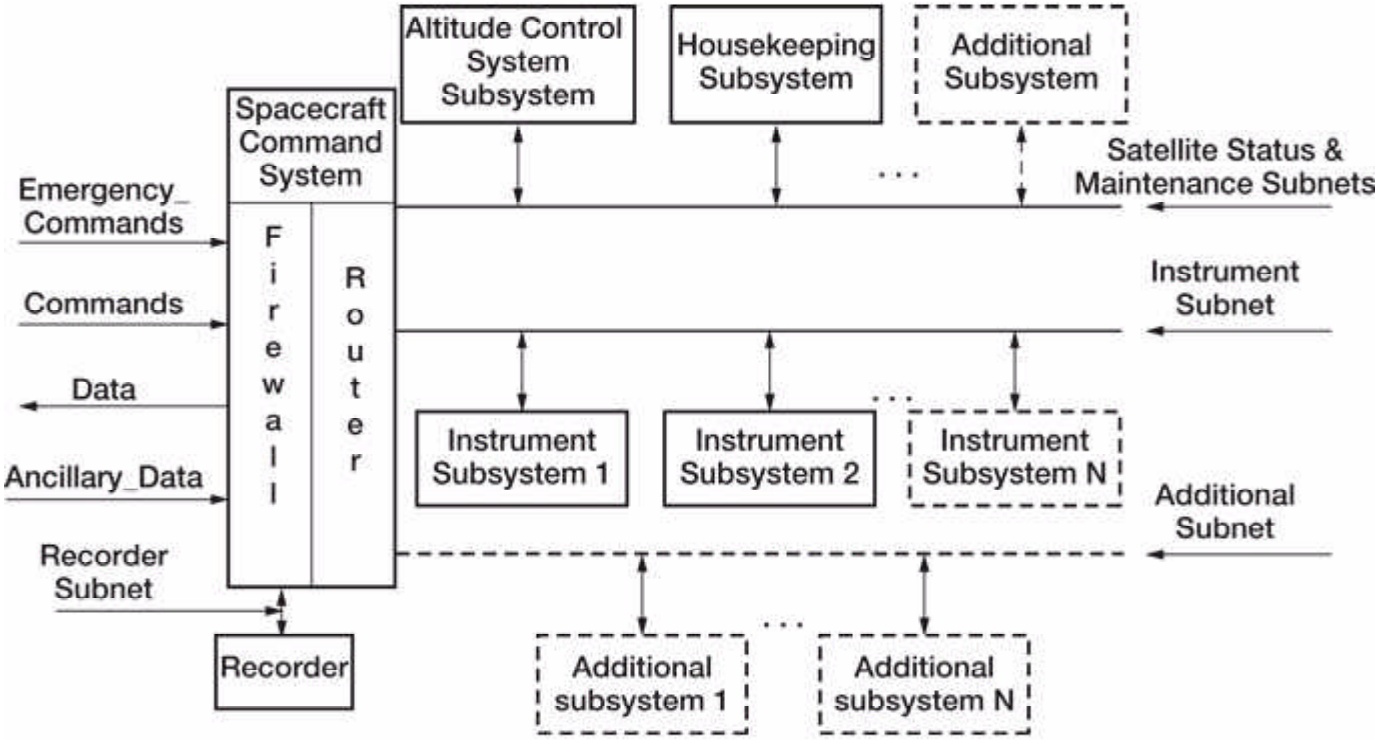
Internet-Protocol-Based Satellite Bus Architecture Designed

NASA is designing future complex satellite missions ranging from single satellites and constellations to space networks and sensor webs. These missions require more interoperability, autonomy, and coordination than previous missions; in addition, a desire exists to have scientists retrieve data directly from the satellite rather than a central distribution source. To meet these goals, NASA has been studying the possibility of extending the Transmission Control Protocol/Internet Protocol (TCP/IP) suite for space-based applications.



Generic satellite bus architecture.
Flow diagram showing emergency commands, commands, data, ancillary data, Recorder Subnet, spacecraft command system (firewall and router), recorder, altitude control system subsystem, housekeeping subsystem, additional subsystem, instrument subsystems 1, 2, and 3, additional subsystems 1 and N, Satellite Status & Maintenance Subnet, Instrument Subnet, and additional subnet.

The objective of this research at the NASA Glenn Research Center was to develop a generic IP-based satellite bus architecture as shown in the diagram. The onboard architecture includes command and control, housekeeping, and science instruments to take measurements and data recorders to store the data until download. The bus also provides

a standard interface to connect each of these components. The goal was to leverage the advances made in the terrestrial Internet while providing a flexible architecture to meet the requirements of different satellite missions.

IP can provide a number of benefits for a satellite mission. First, IP can provide end users with simple access to satellite platforms using standard terrestrial Internet tools (e.g., telnet, ftp, ssh, scp, etc.). Second, IP can permit the integration of heterogeneous platforms by standardizing the communication protocols. These platforms can be developed by universities, foreign governments,or private industries. Finally, it can free NASA from developing and maintaining the communication infrastructure and allow the agency to focus on new missions. NASA will have the flexibility to incorporate research by universities, private industries, and other Government agencies.

Using terrestrial Internet concepts, the generic bus contains four different subnets, as follows: (1) the Satellite Status & Maintenance Subnet, which contains the command, control, and housekeeping instruments; (2) the Instrument Subnet, which contains the science instruments; (3) the Recorder Subnet, which is the central repository for the data collected by the satellite for download; and (4) Additional Subnet(s), which represents one or more subnet(s) that are needed to meet specific mission requirements.

Leveraging terrestrial security concepts, the architecture includes both firewall and a router. The firewall scrutinizes packets on the basis of rules implemented by the missions (e.g., IP addresses or port numbers). The router is responsible for routing data packets to their correct destination, keeping the satellite and instrument commands on separate subnets. Together, these components function as the interface between the local onboard network and the ground. All communications are required to pass through this interface before reaching any module on the satellite. If additional security is required, the mission can implement a Virtual Private Network between the ground and satellite.

Although this study focused on the satellite bus architecture, it, along with other NASA research, shows that true IP connectivity from the ground station to the satellite is a possibility. However, a detailed design is needed for the bus architecture to ensure that each component can be easily and seamlessly integrated. Then, the design must be applied to more complex missions that are coming on the horizon.

Find out more about this research: http://ctd.grc.nasa.gov/5610/5610.html

Glenn contact: Rich Slywczak, 216-433-3493, Richard.A.Slywczak@nasa.gov
Author: Richard A. Slywczak
Headquarters program office:OSF (SCDS)
Programs/Projects: Earth Sciences